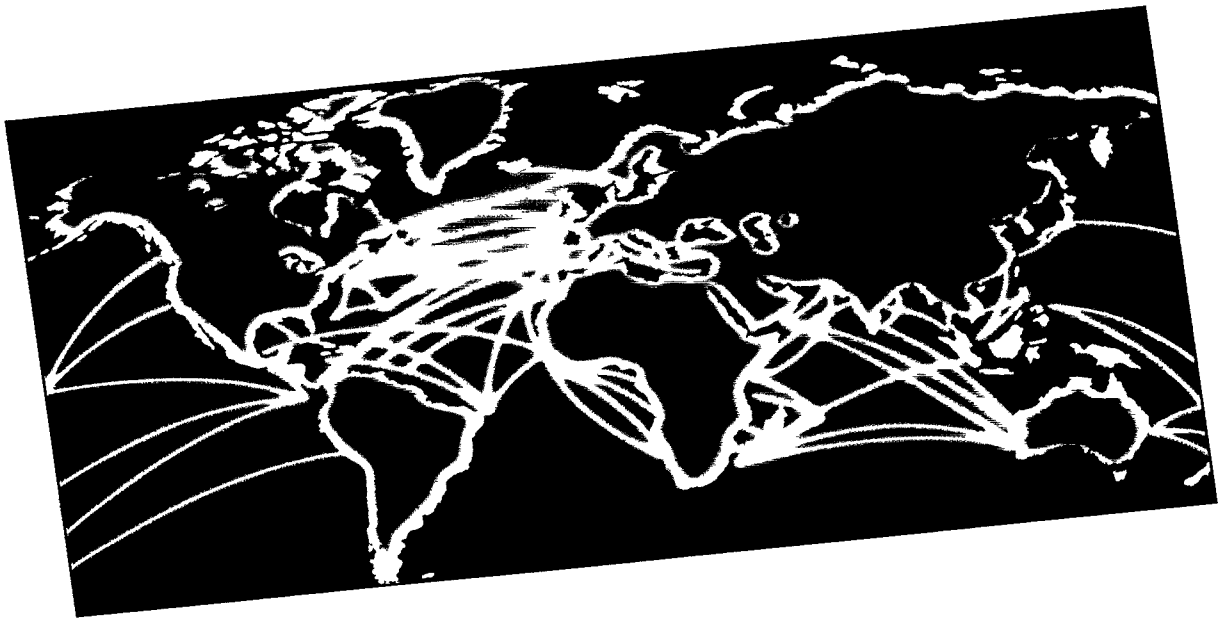

2002 PERCHLORATE CONFERENCE

ABSTRACTS

October 16-18
2002

DoubleTree Hotel
222 North Vineyard Avenue
Ontario, California

ABSTRACTS & BIOS
TABLE OF CONTENTS

LUNCHEON SPEAKERS

ABSTRACTS & BIOS

Luncheon, Wednesday, October 16

EPA SAYS TOXIC SLUDGE IS GOOD FOR FISH

Kathleen M.F. Benedetto

Only in our Nation's capital would we find a federally sanctioned conservation idea suggesting that toxic sludge is good for fish because the fish stop feeding and go away, saving them from the fishermen hoping to catch and eat them for dinner. Who, you might ask, came up with this convoluted justification to allow the Army Corps of Engineers to continue dumping sludge into the Potomac River?

The memo, which contained the suggestion, was included in the EPA's Administrative Record provided to the National Wilderness Institute with other court documents related to NWI's endangered species lawsuit, which was filed in February 2001.

During the summer of 1999, NWI employees had observed bald eagles and peregrine falcons foraging along the Potomac River and in Old Town Alexandria, Virginia. Aware of these species' federally protected status, NWI was surprised that there was no discussion of the potential impact to these species during the construction of the replacement Woodrow Wilson Bridge or other major projects underway in the greater Washington, DC metropolitan region.

In August 1999, NWI initiated the Washington Conservation Project, a program to review the available scientific literature on the flora and fauna, and Environmental Impact Statements (EIS) for ongoing and proposed projects in the region. The literature research was augmented by scientific field surveys.

NWI found that federally listed threatened and endangered species are prevalent throughout the greater Washington, DC metropolitan area. And that several federal projects in the area have progressed unimpeded by the presence of these species.

NWI is currently engaged in litigation with the U. S. Army Corps of Engineers, Environmental Protection Agency, National Marine Fisheries Service, Federal Highway Administration and the U.S. Fish and Wildlife Service regarding violations of the Endangered Species Act arising from the Woodrow Wilson Bridge replacement project and operation of the Washington Aqueduct, the drinking water treatment facility for Washington, DC and parts of Northern Virginia.

In a related action, NWI filed a Clean Water Act complaint in July 2002, against the Corps regarding CWA violations arising from the operation of the Washington Aqueduct.

The Corps' NPDES permit, which expired in 1994, allows them to flush the sludge from the Washington Aqueduct sedimentation basins into the Potomac River. The aqueduct is the only facility on the Potomac River or Northeastern U.S. that is still allowed to dispose of their sludge in this manner. Other facilities throughout the U.S. are required by state and federal agencies to dispose of the sludge by placing it in a landfill or putting it through a sewage treatment facility.

Recently the EPA issued a draft EIS for the Corps' new NPDES permit. The draft permit continues to allow the Corps to discharge the sludge into the Potomac River. At a minimum, the Corps and EPA should institute operating practices consistent with current industry standards at the Washington, DC water treatment facility. Use of industry standards would serve to protect the spawning grounds of the endangered shortnose sturgeon and other anadromous and resident fish in the Potomac River.

Washington, DC should not be exempt from the laws it enforces elsewhere.

BIO

Kathleen M.F. Benedetto
Kathleen M.F. Benedetto is the Program Director of "Voice of Reason on the Environment" at:

National Wilderness Institute
P.O. Box 25766
Washington, DC 20007
(703) 836-7404
(703) 836-7405 - Fax
www.nwi.org

Luncheon, Thursday, October 17

THE FUTURE WITHOUT

William J. Steele

Mr. William J. Steele is the Area Manager, Southern California Area Office of the U.S. Bureau of Reclamation in Temecula, California.

He bagan his career in water resources at the state level in South Carolina as Director of Planning for the Water Resources Commission. He began is Reclamation career in 1975 in the former Southwest Region located in Amarillo, Texas. There, he spent 8-1/2 years in the field of economics, land classification and social assessments working in various positions culminating as the Chief, Economics, Social, and Lands Resources Branch.

From the fall of 1978 to the summer of 1979, Mr. Steele worked in Washington, DC, representing Reclamation at the U.S. Water Resources during the development of the *Manual of Procedures to Implement the Former Principles and Standards of Water and Related Resources Planning*.

From Amarillo, he moved to Denver, Colorado where he served 2-1/2 years as the Lower Missouri Regional Planning Officer.

Following the closure of the Denver Region, Mr. Steele left reclamation for 4 years, spending 2 years with an engineering consulting firm and 2 years as an independent private water resources consultant in Colorado.

In 1990 Mr. Steele returned to Reclamation in the Washington, DC office where he served in various positions in the Program Coordination and Budget office, Office of Policy, and as Lower Colorado Regional Liaison.

For 2-1/2 years from March 1998 until September 2000, he was on detail to the Lower Colorado Region as the Salton Sea Program Manager. Mr. Steele was assigned in March 2002 to the Southern Area Office as the Area Manager.

Mr. Steele has a B.S. in Agricultural Economics (1969), and M.S. in Resource Economics with a Minor in City and Regional Planning from Clemson University, Clemson, South Carolina.

Bill Steele
Area Manager, Southern California Area Office
U.S. Bureau of Reclamation
Temecula, CA 92590
(909) 695-5310
(909) 695-5319 - Fax

TECHNICAL SESSION I

ABSTRACTS & BIOS

PERCHLORATE DEGRADATION IN FIXED BED BIOREACTORS: PILOT SCALE AND LABORATORY RESULTS

Bruce E. Logan, Booki Min, James Xu, Yanguang Song, Lisa Steinberg, Husen Zhang. and Mary Ann Bruns (Penn State University)

Patrick J. Evans, Allyson Chu, and Steven Price (Camp Dresser & McKee, Inc.)

Jaci Batista (University of Nevada, Las Vegas)

ABSTRACT

A series of laboratory and pilot scale tests were conducted as part of a two-phase research program to demonstrate biological treatment of perchlorate contaminated drinking water. In Phase 1, bench scale experiments were conducted on three different fixed-film biological treatment processes capable treating drinking water levels below the detectable limit (4 mg/L): a packed bed amended with acetate; a hydrogen gas fed four-phase (hydrogen gas, water, biofilm, and support media), unsaturated trickle-type packed column; and a membrane-immobilized biofilm reactor. Only one of these systems was allowed to be selected for Phase 2 pilot-scale tests. The acetate-fed packed bed reactor (referred to as the PSU-O_4 system) was selected for Phase 2 pilot-plant tests at the Texas Street well field in Redlands, CA. The purposes of Phase 2 were to: confirm laboratory-derived perchlorate removal efficiencies at pilot scale, to conduct sufficient tests to fully optimize the system over long operation periods in the field, and to continue to research in the laboratory factors that could improve operation of full scale systems.

In the morning session of the perchlorate conference, we present our findings from both phases of our project (laboratory and pilot scale tests). We will open the first half of the morning session with an overview of the various perchlorate remediation technologies available, but will place an emphasis on biological approaches. We then describe the results from the three bench scale studies conducted as a part of Phase 1 of our project.

In the second half of the morning session, we will present the results of our pilot-scale tests. We will show that groundwater from the Crafton Redlands plume containing 75±13 mg/L of perchlorate and 4.0±0.4 mg/L of nitrate could be successfully treated using either a plastic or sand media fixed bed bioreactor. Groundwater was amended with 53±10 mg/L of acetate and 12±4 mg/L of ammonium phosphate to support bacterial growth in the reactor. Perchlorate was completely removed (<4 mg/L) in the plastic media bioreactor at a flow rate of 0.063 L/s (0.34 L/m^{2}s) or at measured reactor detention times of 60 minutes (before backwashing) to 70 minutes (after backwashing). Analysis of intra-column perchlorate profiles revealed that there was simultaneous removal of dissolved oxygen, nitrate, and perchlorate, and that oxygen and nitrate removal was always complete prior to complete perchlorate removal. After consideration of operating data from the plastic media reactor, and data from a companion study using sand media, it is recommended that plastic media be used in fixed bed reactors for treatment of perchlorate-contaminated water with minimum detention times of 60 minutes. In this session, the cost of perchlorate degradation by a fixed bed reactor for a full scale system will be compared to that needed for treatment using a fluidized bed bioreactor or ion exchange.

BIOS

Bruce Logan
Dr. Bruce Logan is the Stan and Flora Kappe Professor of Environmental Engineering at Penn State University. Dr. Logan's areas of expertise are in perchlorate bioremediation, environmental transport processes, biological hydrogen production, biofilms, and bacterial adhesion. He is the author or co-author of over 100 refereed publications and the author of a textbook on chemical transport in natural and engineered systems. He has received several awards including the AEESP Research Frontiers Award, USANC Founders Award and a WEF Biosolids Task Force award. He is a past president of the Association of Environmental Engineering & Science Professors (AEESP). Dr. Logan has several projects on the bioremediation of perchlorate-contaminated waters, including a grant from the National Science Foundation (NSF) on repirotory pathways used by perchlorate-degrading bacteria, and a project funded by the American Water Works Associate Research Foundation (AWWARF) for a pilot-scale demonstration of the PSU-O4 remediation technology for perchlorate conducted in Redlands, California.

Booki Min
Booki Min received a bachelor's degree at the Chungnam National University in Korea. He began his graduate studies at Penn State University in 1999. For his M.S. degree in in 2002 in Environmental Engineering, he studied the use of a headspace biochemical oxygen demand (HBOD) test as an alternative to the conventional BOD test. As a part of his Ph.D. studies, he conducted pilot scale bioreactor tests on treating perchlorate contaminated groundwater. His current studies also include research on biological hydrogen and energy production.

Jianlin (James) Xu
Jianlin (James) Xu is a postdoctoral researcher at Penn State University. He got his B.Sc. in Microbiology at Wuhan University in China, and both his M.Sc. in Food Science and Technology and Ph.D. in Applied Microbiology at Ghent University in Belgium. Dr. Xu's areas of expertise are in microbial fermentation, microbial physiology of perchlorate respiring bacteria, and biological hydrogen production. He is the author or co-author of over 10 journal publications. Currently, he is an active member of the Society for Industrial Microbiology, Association of Environmental Engineering and Science Professors, and American Society for Microbiology.

Yanguang Song
Yanguang Song is a Ph. D candidate in Environmental Engineering at Penn State University. She received her B.S. and M.S. degrees in Environmental Engineering at Tsinghua University in China, where she worked on the synthesis of cationic lignin flocculent and the treatment of dye-wastewater flocculation, and the migration of organic matter through a landfill liner. She has been working on respiratory pathways used by perchlorate-respiring microorganisms for three year as a part of her Ph. D. studies. She has received several awards including first place in Poster Presentations at the Fifth environmental Chemistry Symposium at Penn State, and second place in the Graduate Student Poster Presentations at the 2001 ABASM Fall Meeting. During the summer in 2001, she worked on the pilot-scale perchlorate bioreactor tests in Redlands, California.

Jacimaria R. Batista
Dr. Batista is an assistant professor of environmental engineering in the Department of Civil and Environmental Engineering at the University of Nevada Las Vegas. Her research interests include removal of inorganic contaminants from waters, biodegradation of contaminants, development of new treatment strategies by combining physico-chemical with biological treatment methods, and biological nutrient removal from wastewaters. She has performed work on the removal of the contaminant perchlorate (ClO_4^-) by ion-exchange resins in collaboration with industry and engineering practitioners. She has proposed a treatment system to completely eliminate perchlorate from the environment combining ion-exchange technology and biological reduction of perchlorate in the highly saline brines generated in the process. Jointly with her collaborators, she has investigated the removal of perchlorate from waters using a membrane-immobilized biofilm reactor and has isolated and identified several microbial strains, from a contaminated site in Las Vegas, that are able to reduce perchlorate to innocuous chloride ion.

Patrick J. Evans
Principal Chemical Engineer
Camp Dresser & McKee Inc.
Dr. Evans is a Principal Chemical Engineer with Camp Dresser & McKee Inc. He received his Ph.D. in chemical engineering from the University of Michigan and completed postdoctoral research in environmental microbiology at New York University Medical Center. Dr. Evans has over 13 years of experience in environmental process engineering, chemistry, and microbiology and is a technical resource on projects in environmental remediation and wastewater and drinking water treatment.

Evan Cox, M.Sc.
Principal & Senior Remediation Microbiologist
GeoSyntec Consultants
Evan Cox is a Principal and Senior Remediation Microbiologist at GeoSyntec and holds degrees in microbiology and geology from the University of Waterloo, Ontario. Over the last 10 years, Evan has designed and implemented innovative remedies for rocket fuels and recalcitrant chemicals at defense contractor and aerospace facilities. Evan has pioneered the application of in situ bioremediation for perchlorate-impacted groundwater, conducting laboratory and field remediation evaluations and demonstrations at Department of Defense (DoD) and rocket manufacturing facilities nationwide. As a result of this expertise, GeoSyntec has been awarded two DoD research programs (SERDP & ESTCP) to evaluate and demonstrate the applicability of in situ bioremediation as an effective technology for widespread DoD use at perchlorate sites. Evan has published more than 25 articles on the bioremediation of rocket fuels and recalcitrant chemicals.

TECHNICAL SESSION II

ABSTRACTS & BIOS

TAILORING ACTIVATED CARBON FOR REMOVING PERCHLORATE FROM GROUNDWATER

Fred S. Cannon, Weigang Chen, and Bob Parette

Activated Carbons have been tailored in a manner that improves their adsorption of perchlorate from groundwater. This tailoring has been achieved by thermally pretreating the activated carbon with ammonia gas, or by preloading the activated carbon with organic cation polymers. ed Volumes to breakthrough have been increased by four to ten-fold by this tailoring process.

BIOS

DR. FRED S. CANNON

Dr. Fred S. Cannon is an associate professor at the Pennsylvania State University, where he conducts research on cleaning up the water and air with porous adsorbents. Specifically, he has been tailoring activated carbons to remove various contaminants for ten years. He received a Ph.D. from the University of Illinois, and a Masters and Degree of advanced Engineer from Stanford, and a Bachelors from U.C. Davis. He has practiced as a consulting engineer for ten years; and he was on the design team for the Los Angeles Filtration Plant that processes 600 mgd and serves water to three million people.

WEIFANG CHEN

Weigang Chen is a Ph.D. candidate at Penn State. She received her Masters and Bachelors at Tsinghua University in China.

BOB PARETTE

Bob Parette is a Ph.D. candidate at Penn State. He received his Masters and Bachelors at Worcester Tech, Massachusetts.

PERCHLORATE REMOVAL USING BIOLOGICALLY ACTIVE CARBON FILTRATION

Jess C. Brown[1], Richard Lin, Vernon L. Snoeyink, Lutgarde Raskin, and Eberhard Morgenroth

University of Illinois at Urbana-Champaign

Objectives. The primary objective of this research was to determine how electron donor addition, filter cleaning, and empty-bed contact time (EBCT) affected perchlorate removal performance in a biologically active carbon (BAC) filter. Since perchlorate has been detected in a wide range of drinking water sources, a secondary objective of this research was to examine the effect of various water quality parameters on perchlorate removal in a BAC filter.

Procedure. A continuous flow, packed-bed granular activated carbon (GAC) reactor system was constructed. Extensively contacting the GAC with dechlorinated tap water and perchlorate stimulated biological activity. A syringe pump was used to add acetate as an exogenous electron donor. Influent water consisted of deionized, distilled water (DDW) or Colorado River water (CRW). Influent perchlorate and dissolved oxygen (DO) concentrations, pH, and EBCT were typically set at 50 µg/L, 0.5-2.5 mg/L, 7.5, and 15 minutes, respectively. Terminal restriction fragment length polymorphism (T-RFLP) was used to characterize the microbial community structure within the BAC filter and to correlate changes in structure to perchlorate removal performance and operational parameters.

Results. When operational and water quality parameters were varied, the following observations were made:

- Low concentrations of an exogenous electron donor, low DO concentrations, low nitrate concentrations, and an EBCT ^{3} 3 minutes were required to achieve and sustain the complete removal of 50 mg/L perchlorate in a BAC filter.
- Most, if not all, of the added exogenous electron donor was removed during biofiltration.
- BAC filtration was robust with respect to perchlorate removal for influent perchlorate concentrations of 10-300 µg/L, influent sulfate concentrations of 0-220 mg/L, influent pH values of 6.5 to 9.0, and operating temperatures of 5-22°C. The BAC filter also responded well to short interruptions of electron donor addition.
- Influent concentrations of DO and nitrate impacted the vertical depth within the BAC bed at which significant perchlorate reduction occurred. It was observed that perchlorate removal to below detection did not occur until bulk liquid DO and nitrate concentrations were d•0.4 mg/L and d•0.5 mg/L, respectively. Alternatively, batch tests showed that increased levels of nitrate reduction can accelerate perchlorate reduction kinetics.
- Approximately once every 50 days, excessive biomass in the BAC filter resulted in clogging, destabilizing perchlorate removal performance. A short cleaning procedure restored consistent perchlorate removal to below detection.
- When tested with perchlorate-contaminated CRW, BAC filtration proved to be a very efficient perchlorate removal process.
- The T-RFLP analyses showed that perchlorate-reducing bacteria of the genera *Dechloromonas* and *Dechlorosoma* were present and that *Dechlorosoma* was the dominant population in most samples.

Conclusions. In general, this research has demonstrated how electron donor addition, biomass control, and EBCT can be adjusted to maximize perchlorate removal efficiencies and minimize post-treatment requirements for a BAC filtration process. It has also shown how BAC filtration is an environmentally robust process, suggesting that it can be applied to a variety of natural waters with broad variations in chemical and physical characteristics. The T-RFLP data have indicated that a significant fraction of biomass consists of perchlorate-reducing bacteria. Future work will focus on further evaluating mechanisms of perchlorate removal using molecular microbial methods and mathematical modeling of mass transport in the biofilm.

(Footnotes)

[1] Current address: Carollo Engineers, 12592 W. Explorer Dr., Suite 200, Boise, Idaho, 83713

BIOS

RICHARD LIN

Education:
Bachelor of Science – Civil and Environmental Engineering,
University of Illinois Champaign-Urbana, 2001
Master of Science – Civil and Environmental Engineering,
University of Illinois Champaign-Urbana, expected May 2003
Current position: Research assistant, currently studying the biological community inside a perchlorate-reducing biologically active carbon filter.

JESS C. BROWN, PH.D.

Jess C. Brown has a Ph.D. and M.S. in Environmental Engineering, and a B.S. in Civil Engineering from University of Illinois at Urbana-Champaign. He has a B.A. in Environmental Science and Public Policy from Harvard University, Cambridge, Massachusetts.
Current Position:
Carollo Engineers, 12592 W. Explorer Dr. #200, Boise, ID 83713
(208) 376-2288 / (208) 376-2251 (Fax) / E-mail: jbrown@carollo.com
Dr. Brown is a member of the American Water Works Association, and the International Water Association.

DR. VERNON L. SNOEYINK

Vernon L. Snoeyink was appointed to the Civil and Environmental Engineering faculty at the University of Illinois in 1969, and was named Ivan Racheff Professor of Environmental Engineering in 1989. His primary area of research is drinking water quality improvement and he has focused his efforts on the removal of organic contaminants such as pesticides and taste and odor by activated carbon adsorption, corrosion, and red water control. In 1980, he coauthored the textbook, *Water Chemistry*, published by John Wiley & Sons. He has been a Trustee of the American Water Works Association Research Foundation, President of the Association of Environmental Engineering Professors, Vice-Chair of the Drinking Water Committee of the USEPA Science Advisory Board, and a member of the Editorial Advisory Board of the *Journal of the American Water Works Association*. He is now a member of the Editorial Advisory Committee of *Aqua*. He is a member of the National Academy of Engineering and has been a member of several National Research Council committees, and he consults regularly for private industry and public agencies throughout the USA and Canada. He received his B.S. and M.S. degrees in civil engineering and his PhD in water resources engineering from the University of Michigan.

DR. EBERHARD MORGENROTH

Dr. Eberhard Morgenroth is a research assistant, currently studying the biological community inside the perchlorate-reducing biologically active carbon filter. He has a Ph.D. from Tech. University, Munich (Environmental Engineering), M.S. from U.C. Davis (Civil and Environmental Engineering), and M.S. from Tech. University, Hamburg-Harburg (Civil and Environmental Engineering). Dr. Morgenroth's current address is:
University of Illinois, Department of Civil and Environmental Engineering, and Department of Animal Sciences, 3219 Newmark Civil Engineering Laboratory, 205 North Mathews Avenue MC-250, Urbana Illinois 61801. (217) 333-6965 / (217) 333-6968 (Fax) /
E-mail: emorgenr@uiuc.edu

DR. LUTGARDE RASKIN

Dr. Lutgarde Raskin is an associate professor in the Department of Civil and Environmental Engineering with the University of Illinois at Urbana-Champaign.
205 N. Mathews Ave., Urbana, IL 61801
(217) 333-6964 / (217) 333-6968 (Fax) / E-mail: lraskin@uiuc.edu
Dr. Raskin is a member of the American Society for Microbiology, American Water Works Association, Association of Environmental Engineering Professors, International Water Association, Royal Flemish Association of Engineers, and the Water Environment Federation.

SYNOPSIS OF PILOT STUDY EVALUATION OF ALTERNATIVE ANION EXCHANGE RESINS FOR REMOVAL OF PERCHLORATE FROM DRINKING WATER

Earth Tech and Lockheed Martin conducted pilot testing on several anion exchange resins to evaluate the effectiveness and practicality for treating perchlorate impacted groundwater to a standard suitable for use as a blended drinking water source. The overall objectives of the pilot test were to evaluate the effectiveness of fixed bed anion exchange technology for removal of perchlorate (ClO_4^-) from impacted groundwater, and its practical implementation and use in conjunction with granular activated carbon based trichloroethene (TCE) groundwater treatment systems.
Pilot studies were conducted on the following anion exchange resins:

- Type I Polystyrene Resin
- Type II Polystyrene Resin
- Perchlorate Selective Resin (BiQuat)~~(nitrate selective resin)~~
- ~~Type I~~ Polyacrylic Resin
- Nitrate Selective Resin
- Highly Selective Resin

The performance evaluation of the various resins included removal efficiency, impact of competing anions, regenerative capability, and leakage. The pilot studies also collected operational data, such as bed volumes between regeneration and regenerant requirements used in the cost evaluations of the various treatment alternatives.

BIO

TRENT HENDERSON
Trent Henderson is a senior project engineer in the Global Environmental Services Division of Earth Tech. For the past eight years, Mr. Henderson has designed, implemented and optimized soil remediation and groundwater treatment systems ranging from 50 to 9,000 gallons per minute to treat recalcitrant organic and inorganic compounds. He has performed several technology and cost evaluations of various perchlorate treatment technologies for Earth Tech clients. Additionally, he was the lead process engineer in the development of preliminary designs of fixed bed anion exchange perchlorate treatment systems.

Mr. Henderson earned a B.S. in Chemical and Petroleum Refining Engineering from the Colorado School of Mines. He holds a Professional Engineering License in Chemical Engineering from the State of California.

ENVIRONMENTAL DATA QUALITY ISSUES AFFECTING DOD MISSION AND OPERATIONS

Jackie Sample, Chair, DoD Environmental Data Quality Workgroup

Environmental sampling and testing data are used as the basis for virtually all environmental decisions. Decisions based on inappropriate or unreliable data affect DoD's compliance with regulations, waste resources for data collection, delay cleanup actions, and negatively impact operational readiness. For this reason, it is extremely important for DoD to define appropriate *data quality objectives (DQOs)* for environmental data collection efforts, based on the decisions to be made (i.e. the specific, intended uses for the data). This process is challenging, for the following reasons:

1. Many federal and state agencies have independently established their own policy and guidance for the collection of environmental data. Because requirements may vary from state to state and region to region, personnel responsible for the development and review of data collection planning documents (e.g. Quality Assurance Project Plans or QAPPs) have different expectations for acceptable data collection strategies, as well as the content and format of planning documents. Intergovernmental guidance for developing project-specific QAPPs using *graded approaches* is needed.

2. Regulatory target compliance and cleanup levels are becoming increasingly stringent. In the case of perchlorate, for example, regulators are establishing target quantitation limits below reliable method quantitation limits, without proper consideration for method limitations or measurement uncertainty inherent in real, environmental matrices. In many cases, existing, prescriptive analytical methods developed or approved by EPA (e.g. Method 314 for perchlorate) are not sensitive enough to support current studies. Frequently, methods are being applied in broad, survey fashion, in an attempt to measure long lists of analytes, even when method performance is very poor for certain groups of these analytes. These problems are driving a move away from traditional method approaches and toward the use of *performance-based measurement systems* (PBMS), in which methods are optimized to ensure analytical data will support their intended uses. Guidance on implementing PBMS is needed.

3. Ninety-five percent of DoD laboratory testing is outsourced; however, the qualifications and performance of these laboratories vary considerably. Improper laboratory practices and fraud have cost DoD millions of dollars in unreliable data, resampling expenses, and delayed clean-ups and site closures. Promoting *best-value* in DoD laboratory procurements and deterring improper laboratory practices require improvement in current DoD laboratory contracting practices, the implementation of uniform laboratory quality systems requirements across all regions, cost-effective oversight, and a means to share laboratory performance information across Components.

This presentation describes environmental data quality improvement initiatives being taken by the DoD Environmental Data Quality Workgroup (EDQW), under Navy lead, to promote the collection of environmental data that are suitable for their intended uses.

BIO

JACKIE SAMPLE
ENVIRONMENTAL LABORATORY PROGRAM MANAGER
DEPARTMENT OF THE NAVY, CHIEF OF NAVAL OPERATIONS (CNO N45)

Since 1994, Ms Jackie Sample has provided technical support to the Office of the Chief of Naval Operations (CNO N45) on issues related to environmental sampling and testing. She currently functions as the Navy Environmental Laboratory Program Manager for CNO N45 and chairs the Department of Defense (DoD) Environmental Data Quality Workgroup for the Deputy Assistant Secretary of the Navy (Environment), as lead Service for DoD. She provides technical expertise, develops policies and procedures, and represents the Navy and DoD on issues related to laboratory operations, environmental sampling and testing, quality programs and laboratory accreditation.

Ms. Sample has served on the Board of Directors for the USEPA National Environmental Laboratory Accreditation Program, and she represents DoD on intergovernmental workgroups, such as the USEPA Intergovernmental Data Quality Task Force. In addition, she serves on the Public Affairs Committee of the International Laboratory Accreditation Cooperative and on the Environmental Advisory Committee and the Accreditation Council of the American Association for Laboratory Accreditation.

Ms. Sample has over 30 years experience with the Navy, including 15 years in management of laboratory analytical operations at the former Charleston Naval Shipyard. She has also worked for Mobile Research and taught in the Chemistry Department at Trident Technical College, Charleston, SC. Ms. Sample has a B.S. in Chemistry and a M.S. in Management with a concentration in Computer Resource Management.

TECHNICAL SESSION III

ABSTRACTS & BIOS

A FUNDAMENTAL STUDY OF ION EXCHANGE FOR PERCHLORATE REMOVAL FROM GROUND WATER

By
Anthony R. Tripp, Ph.D. and Dennis A. Clifford, Ph.D., P.E.
University of Houston
Department of Civil and Environmental Engineering, Houston, Texas 77204-4003

Perchlorate contamination of ground water has been confirmed in at least 20 states. To protect public health, the California Department of Health Services (CDHS) has lowered the advisory action level for perchlorate in drinking water from 18 mg/L to 4 mg/L while the US Environmental Protection Agency has proposed a maximum contamination level of 1 mg/L based on the potential for perchlorate to inhibit the uptake of iodide by the thyroid gland. To reach these low levels, efficient perchlorate removal processes will be required. The purpose of this research was to determine if a technically efficient and cost effective ion-exchange process could be developed for the removal of perchlorate from groundwater.

It was known that perchlorate tends to be strongly adsorbed onto anion resins, and that regeneration is difficult. This was confirmed during some preliminary tests of the ion-exchange process using two very different strong-base anion resins. For these proof-of-concept tests, a moderately hydrophobic resin, with a polystyrene matrix, and a hydrophilic resin, with a polyacrylic matrix, were studied to establish their capacity and regenerability when removing perchlorate from a representative simulated ground water matrix.

Following the preliminary tests, seventeen commercially available strong-base anion resins were evaluated using binary perchlorate-chloride isotherm tests. This extensive series of tests established the relative perchlorate affinities and uptake rates at mg/L perchlorate levels as a function of resin matrix, functional group, and temperature. Perchlorate affinities ranged over 2.5 orders of magnitude, and increased with increasingly hydrophobic matrices and functional groups, and with increased cross-linking. As temperature increased from 25 to 60°C, perchlorate selectivity decreased markedly for all but the polyacrylic resins. These results suggested the use of elevated temperature regeneration with sodium chloride.

Bench-scale column tests confirmed the ability of equilibrium multicomponent chromatography theory computer models to forecast ion-exchange column exhaustion results. These models indicated that it was possible to remove perchlorate from groundwater to levels below 1 mg/L using three possible techniques: complete exhaustion and regeneration (using resins with low perchlorate selectivity), partial exhaustion and regeneration (using resins with low and medium perchlorate selectivity), and exhaustion and replacement (using resins with very high perchlorate selectivity).

BIOS

DR. DENNIS A. CLIFFORD

Dr. Dennis Clifford is Professor of Environmental Engineering in the Department of Civil and Environmental Engineering at the University of Houston where he conducts research and teaches courses in Water Chemistry and Physical-Chemical Treatment Processes. He is a Professional Engineer with more than thirty years experience in water treatment with special emphasis the removal of inorganic and radioactive contaminants from drinking water. Professor Clifford's doctoral degree in Environmental Engineering was earned at the University of Michigan on the subject of multicomponent ion exchange for drinking water treatment. His bachelor and master's degrees in Chemical Engineering were earned at Michigan Technological University and the University of Michigan.

University of Houston, Department of Civil and Environmental Engineering,
Houston, TX 77204-4003.
(713) 743-4266
E-mail: daclifford@uh.edu

ANTHONY R. TRIPP

Dr. Anthony R. Tripp is a Postdoctoral Researcher at the University of Houston. He has a Ph.D. in Environmental Engineering from the University of Houston, an M.S. in Chemical Oceanography from Texas A&M University, and a B.S. in Marine Science from Texas A&M. His Ph.D. research included Phase I of the AWWARF project to determine the fundamentals of perchlorate removal by ion exchange as well as research in the methods of removing arsenic from drinking water sources.

University of Houston, Department of Civil and Environmental Engineering,
Houston, TX 77204-4003.
(727) 865-7664.
E-mail: tonyelsa@earthlink.net

REMOVING PERCHLORATE FROM GROUNDWATER ION EXCHANGE BRINE TREATMENT AND REUSE FOR PERCHLORATE CONTAMINATED GROUNDWATERS

Thomas Gillogly, Geno Lehman, Lee Aldridge - Montgomery Watson Harza
Dennis Clifford, Deborah Roberts - University of Houston

Since the discovery of perchlorate contamination in a number of California groundwaters in 1997, it has been detected in many other locations across the country. The United States Environmental Protection Agency (USEPA) estimates that groundwaters in 40 states have the potential to be contaminated with perchlorate, and has confirmed perchlorate releases in at least 18 of them. Few technologies have been proven to consistently remove perchlorate down to low microgram per liter concentrations. While various ion-exchange resins have been shown to remove perchlorate, their regeneration and the treatment/disposal of the spent brine has been problematic.

This American Water Works Association Research Foundation (AwwaRF) two phase project, with a recently awarded scope extension, is a collaborative effort between Montgomery Watson Harza (MWH) and the University of Houston. The second phase of the project and its extension is focused on evaluating innovative methods of ion-exchange operation through the use of a field-scale demonstration plant. This project and presentation will focus on the evaluation of three fundamentally different brine treatment and reuse processes.

1. Biological Brine Treatment. The biological brine treatment system is a 208 L (55 gal) closed reactor with multiple taps to introduce spent brine, draw-off treated brine or sample water quality. The system is operated as a sequencing batch reactor (SBR). Spent 3 percent (0.5 N NaCl) brine from the regeneration of the ion exchange resin is introduced to the nitrate and perchlorate degrading culture in the reactor. The brine and culture are mixed for a period of 21 hours, while the nitrate and perchlorate are biodegraded. The mixture is then allowed to settled under quiescent conditions for 1 hour. The clarified treated brine is then drawn through two 5-15 µm cartridge filters to remove excessive non-settleable bacteria. The chloride concentration of the filtered, treated brine is then adjusted before its reuse as the regenerant solution. The system utilizes a marine sediment inoculum to biologically reduce both perchlorate and nitrate in a 3 percent brine solution. Acetic acid is supplied to this culture as an electron donor for the reduction process.

2. Physical/Chemical Brine Treatment. The physical/chemical brine treatment system (employs a high-pressure and high-temperature catalytic process to reduce the nitrate and perchlorate in the spent brine. After the process, the treated brine is then ready for reuse without subsequent treatment. The system uses a stoichiometric dose of a chemical reductant (ammonia) based on the measured concentrations of nitrate and perchlorate in the spent brine. The slight excess of ammonia carried in the treated brine is flushed from the ion exchange bed during the rinse process, and consequently, is not detected in the treated water.

3. Electrolytic Brine Treatment. A simple bipolar electrochemical cell electrolytically reduces the perchlorate and/or nitrate present in the spent ion exchange brine. Once reduced the brine can be immediately reused. This process does not require the addition of an electron donor as with the biological process, or a reductant as with the physical/chemical treatment process.

BIOS

THOMAS GILLOGLY, PH.D.

Ph.D., Environmental Engineering, University of Illinois at Urbana-Champaign
M.S., Civil Engineering, University of Illinois at Urbana-Champaign
B.S., Chemical Engineering and Engineering & Public Policy (Environmental Engineering minor), Carnegie-Mellon University

Dr. Gillogly is a member of MWH's Applied Research Department in Pasadena, California. He has experience with managing and conducting full-scale, pilot-scale, and desktop projects investigating water quality and regulatory compliance issues. His expertise focuses on the control of inorganic contaminants, disinfection by-products, taste-and-odor causing compounds and synthetic organic compounds.

He is currently involved in two AwwaRF studies investigating the treatment of perchlorate-contaminated waters. One study is investigating the use of a novel bubbleless hydrogen fed membrane biofilm reactor for the direct biological reduction of perchlorate and nitrate. The second study is demonstrating the long-term performance of ion exchange treatment for perchlorate removal and evaluating two alternatives for brine treatment and reuse. The methods of brine treatment include biological and physical-chemical reduction of the nitrate and perchlorate concentrated in the brine. Each of these two-phase AwwaRF studies are in the demonstration (second) phase of testing.

Dr. Gillogly, Applied Research Department, MWH
555 E. Walnut Street, Pasadena, CA 91101
(626) 568-6330 / (626) 568-6323 / E-mail: thomas.gillogly@ mwhglobal.com

DR. SAMER ADHAM

Dr. Samer Adham received his B.S. in Civil Engineering and M.S. in Environmental Engineering from King Fahd University of Petroleum and Minerals in Saudi Arabia. Dr. Adham also received his Ph.D. in Environmental Engineering from the University of Illinois at Urbana – Champaign. Dr. Adham is currently the Vice President and manager, of the Applied Research Department of Montgomery Watson Harza. His experience includes bench-, pilot- and demonstration-scale studies for the evaluation of membrane processes for drinking water and wastewater treatment and water reuse. Dr. Adham has numerous peer-reviewed journal publications and conference presentations.

DR. DEBORAH ROBERTS

Dr. Deborah Roberts is an Associate Professor of Civil and Environmental Engineering at the University of Houston. She has a Doctor of Philosophy, Microbiology, from University of Alberta, and a B.S. in Microbiology from University of Alberta. She can be reached at:

Dr. Deborah Roberts
Department of Civil and Environmental Engineering,
University of Houston, Houston, TX 77204
(713) 743-4281 / (713) 743-4260 (Fax) / E-mail: djroberts@uh.edu

EX SITU BIOLOGICAL TREATMENT OF PERCHLORATE CONTAMINATED GROUNDWATER USING BIOLOGICAL FLUIDIZED BED REACTORS

WILLIAM J. GUARINI
Envirogen, Inc.

CASEY WHITTIER
US Filter

Perchlorate has been identified as a water contaminant in at least 14 states, including California, Nevada, New Mexico, Arizona, Utah, Massachusetts and Texas. Current estimates suggest that the compound may affect the drinking water of as many as 15 million people. Biological treatment represents a proven technology for the effective and economical removal of perchlorate from water.

Biological fluidized bed reactors (FBRs) are currently degrading perchlorate in contaminated groundwater at three U.S. sites providing effluent with less than the current practical quantitation limit for perchlorate (< 4 ppb) in more than 5 million gallons per day of groundwater.

This paper will discuss the biological degradation of perchlorate, the FBR, show full scale operating data and provide the economics of FBR use. It will also discuss the California Department of Health Services' (Ca DHS) recent conditional approval of the biological FBR in drinking water pollution and the corresponding FBR treatment system accepted by the Ca DHS.

BIOS

WILLIAM J. GUARANI
Vice President, Envirogen, Inc.
4100 Quakerbridge Road
Lawrenceville, NJ 08648
(609) 936-9300 / (609) 936-9221 (Fax) / E-mail: guarini@envirogen.com

CASEY WHITTIER
Product Manager - RBR Systems
U.S. Filter's Envirex Products
1901 S. Prairie Avenue
Waukesha, WI 53189-7374
(262) 521-8506 / (262) 547-4120 (Fax) / E-mail: whittierc@usfilter.com

TECHNICAL SESSION IV

ABSTRACTS & BIOS

TEXAS TECH SCIENTISTS PRESENT A BROAD RANGE OF PERCHLORATE-RELATED ENVIRONMENTAL TOXICOLOGY DATA FROM LAB AND FIELD STUDIES

TIEHH / TTU Presenters

The Institute of Environmental & Human Health in addition to faculty from Texas Tech University's Biology and Civil Engineering Departments have been engaged in research on the ecological consequences of environmental perchlorate contamination for the past four years. Scientists from Texas Tech will present a broad range of perchlorate-related environmental toxicology data generated from laboratory and field studies.

Dr. Todd Anderson will provide introductory comments for the group from Texas Tech including a brief introduction of topics to be covered in this session. He will address the analytical chemistry of perchlorate in environmental matrices including biological tissues and provide an overview of the groups' efforts at contaminated field sites in Texas.

Dr. Andrew Jackson will address the natural attenuation of perchlorate in bottomland hardwood wetlands and fresh water streams. The purpose of Dr. Jackson's studies were to examine the fate of perchlorate including biological transformation potential in groundwater surfacing into streams and wetlands as well as the fate of the perchlorate in surface water and sediments. Studies discussed will include discrete depth (cm) sampling (dialysis samplers), plant tissue extracts, degradation studies, and limited transport studies, and microcosm studies designed to determine the rates of degradation in sediments.

Dr. Jim Carr will present data related to the effects of ammonium perchlorate on frog development. Dr. Carr's laboratory has observed effects of ammonium perchlorate on thyroid function, limb development, and reproductive development at environmentally relevant concentrations of perchlorate. Because frogs are more sensitive to thyroid disruption than humans and or other mammals, they are useful sentinels for assessing perchlorate contamination in the environment.

Jacques Rinchard will describe the results of his laboratory studies examining the effects of perchlorate on fish reproduction. Specifically, zebrafish were reared for several weeks in water containing ammonium perchlorate at environmentally relevant concentrations. Endpoints measured included spawned egg volume (index of reproductive fitness), egg fertilization rate, accumulation of perchlorate in whole fish, and thyroid histology.

Drs. Scott McMurry and Phil Smith will address the exposure impacts of environmental perchlorate contamination on terrestrial organisms. Although perchlorate is extremely soluble in aqueous solutions, terrestrial organisms including birds, reptiles, and mammals are at risk of exposure due to consumption of water, plants, and soils. Exposure data from multiple contaminated sites in the United States will be presented.

Dr. Ken Dixon will describe a suite of models that have been developed to simulate the transport, uptake, and effects of perchlorate in aquatic and terrestrial ecosystems. The emphasis in model development to date has been on uptake and distribution of perchlorate in mammal, fish, amphibian, bird, and plant species. The animal food-chain models are stochastic, individual based models. The model structure is a compartmental, physiologically-based toxicokinetic (PBTK) model to simulate the uptake and distribution of perchlorate, particularly the concentration at the thyroid gland. A second sub-model is a model of the thyroid gland based on the models of DiStefano and Saratchandran.

Finally, Drs. Todd Anderson and Phil Smith will address future ecological research needs pertaining to perchlorate and address questions from attendees.

BIOS

TODD ANDERSON
Todd Anderson is an Associate Professor in the Department of Environmental Toxicology and The Institute of Environmental and Human Health (TIEHH) at Texas Tech University. His teaching and research focuses on the movement of organic chemical contaminants in the environment in order to evaluate and better characterize potential exposure of organisms to contaminants. One of his primary research interests currently is the development of chemical assays which can be used to characterize the availability of aged contaminants in soil.

He received M.S. and Ph.D. degrees in Environmental Toxicology from the University of Tennessee, Knoxville where he held a Department of Energy Research Fellowship at Oak Ridge National Laboratory. Dr. Anderson was a Postdoctoral Associate and Research Affiliate Professor at Iowa State University from 1992-1996 and an Assistant Professor in the Department of Environmental Toxicology and The Institute of Wildlife and Environmental Toxicology (TIWET) at Clemson University from 1996-1997.

In 1996, Dr. Anderson received the SETAC/Roy F. Weston Environmental Chemistry Award, an award given annually for contributions made to the field of environmental chemistry. Dr. Anderson was selected by Sigma Xi as the Southwest Regional Young Investigator for 1999 and 2001 based on his work with chemical contaminants in soil-plant systems.

ANDREW JACKSON
Andrew Jackson is currently an Assistant Professor of Civil Engineering at Texas Tech University. Dr. Jackson's general field of expertise is related to the remediation of hazardous wastes in the surface and subsurface. His research has involved a wide variety of contaminants including perchlorate, chlorinated solvents, crude Oil, BTEX, pesticides, pharmaceuticals, and other anthropogenic compounds. His work includes a variety of field sites and environmental conditions from salt marshes to Superfund sites. In addition, his work involves long-term recycling of drinking water, including treatment, optimization, and fate of persistence of undesirable chemical compounds. Currently, he is researching the fate of chemicals in surface/subsurface transition zones. Dr. Jackson's teaching interest include a variety of courses from introductory Environmental Engineering to Bioremediation and Advanced Water Treatment. He recently received the Lockheed Martin Faculty Teaching Award for the College of Engineering.

Jackson received his M.S. and Ph.D. from Louisiana State University in Environmental Engineering from the Department of Civil and Environmental Engineering where he held an Alumni Fellowship. Dr. Jackson was a Postdoctoral Associate at Louisiana State University from 1996-1998. He serves as the faculty advisor to the Society of Environmental Professionals and is active in a number of professional organizations including SETAC, ACS, ASCE, WEF. He is currently serves on the editorial board of the journal, *Water, Air, and Soil Pollution.*

JIM CARR
Jim Carr is an Associate Professor of Biological Sciences at Texas Tech University. He received his B.S. in Zoology from Rutgers University and a M.A. and Ph.D. in Zoology/Endocrinology from the University of Colorado, Boulder. He has studied the development and endocrine physiology of amphibians for twenty years, and has 37 publications.

PHIL SMITH
Phil Smith serves as Research Assistant Professor at The Institute of Environmental and Human Health, Texas Tech University. Phil is an ecotoxicologist who earned his Ph.D. in Environmental Toxicology at Texas Tech in 2000. His research interests center on ecological and physiological characteristics of organisms, populations, and environments that contribute to contaminant exposure and adverse effects. His research examines pathways of contaminant exposure among mammals, birds, and a variety of aquatic organisms, trophic-level transfer of environmental contaminants, and physiological and population-level responses to contaminant exposure.

Phil serves as field and project coordinator for a SERDP funded research project investigating the ecological effects of perchlorate and as assistant project coordinator for a similar study in the Brazos River Watershed. He is also working on a USDA sponsored project investigating the potential risks of food items grown with perchlorate-contaminated irrigation water. Phil currently serves on the editorial board for the journal *Environmental Pollution*.

SCOTT MCMURRY
Scott McMurry is an Assistant Professor in the Department of Environmental Toxicology and The Institute of Environmental and Human Health at Texas Tech University. Scott's interests center on the exposure and effects of chemical stressors on terrestrial and semi-aquatic wildlife species, including mammals, reptiles, and birds.

He and others are currently involved in a variety of studies, including small mammals and heavy metals at the Anaconda Smelter in Montana, crocodiles and organochlorines in Belize, and a variety of wildlife and perchlorate in Texas.

KEN DIXON
Ken Dixon holds the rank of Professor in the Department of Environmental Toxicology and The Institute of Environmental and Human Health at Texas Tech University. Dr. Dixon received his B.S. degree in Forestry from the University of Florida in 1964. In 1968 he received his M.S. in Forestry, also from the University of Florida, specializing in statistics and systems engineering. From 1968 to 1971, Dr. Dixon worked as a biometrician in the Institute of Statistics at North Carolina State University. In 1974 Dr. Dixon received his Ph.D. in the School of Natural Resources at The University of Michigan. After graduating, Dr. Dixon took a post-doctoral position as an ecologist and modeler at Oak Ridge National Laboratory. His research primarily involved modeling the impact of heavy metals on both aquatic and terrestrial ecosystems. Additional activities included the environmental impact assessment of nuclear power plants. In 1976, Ken joined the University of Maryland Appalachian Environmental Laboratory. From 1984 to 1992, Dr. Dixon was Director of Wildlife Research for the Washington Department of Wildlife. Dr. Dixon was Associate Professor in the Department of Environmental Toxicology and The Institute of Wildlife and Environmental Toxicology at Clemson University from 1992 to 1997.

Dixon's research interests include developing and applying computer simulation models to predict the movement of toxic chemicals in the environment and their effects on human and wildlife populations. Dr. Dixon also studies the spatial distribution of toxicants and effects at ecosystem, landscape, and regional scales by integrating models with geographic information systems. Dr. Dixon has taught courses in modeling, geographic information systems, ecosystems analysis, biometry, and wildlife management.

ALTERNATIVE PRELOADING OF ION EXCHANGE RESINS TO IMPROVE PERCHLORATE AND CHROMATE REMOVAL

Pierre Kwan[1], Mark Benjamin[2], Steve Reiber[1]
[1]HDR Engineering, Inc , Seattle, WA [2]University of Washington, Seattle, WA

The removal of trace quantities of chromate (CrO_4) and perchlorate (ClO_4) from groundwater poses a significant challenge to the water industry. Among the few feasible treatment options, packed bed adsorption onto strong-base anionic (SBA) ion exchange (IX) resins is arguably the most effective and straightforward. However, the use of SBA resins for such applications is hindered by two major problems: the appearance of chromatographic peaks of less strongly bound species, especially arsenate (AsO_4) and nitrate (NO_3) in the column effluent, and the difficulty of regenerating the resins efficiently at reasonable cost.

For typical waters, the dominant anion that adsorbs to SBA resins is sulfate. As a result, that ion "pushes" weakly bound ions ahead of it, generating significant chromatographic peaks of those ions just before sulfate breakthrough. If a column packed with SBA resin were used to remove CrO_4 and ClO_4 from water containing AsO_4 or NO_3, the treatment cycle would have to be terminated significantly before sulfate breakthrough, and long before breakthrough of CrO_4 or ClO_4. Only in this way could a utility be certain that AsO_4 or NO_3 peaks with concentrations exceeding their respective MCLs would not appear in the effluent. Thus, the useful capacity of the resin for ClO_4 and CrO_4 removal would be less than the theoretical capacity.

The second impediment to the use of SBA resins to treat CrO_4 or ClO_4 is that the resins have a very high affinity for these ions. While that characteristic is attractive during the treatment step, it poses problems when the resin needs to be regenerated. If effective regeneration is to be achieved by exchanging the adsorbed ions with Cl^{-}, a very high concentration of Cl^{-} is required. The amount of Cl^{-} salt needed in such cases can be prohibitively expensive. Reducing the cost of regeneration by using less salt is counter-productive because the result is an incomplete release of the adsorbed anions, steady accumulation of CrO_4 or ClO_4 on the resin, and ever quicker breakthroughs in subsequent treatment cycles.

However, these problems can be substantially reduced by focusing on alternative operating strategies. One such idea is to preload and regenerate the SBA resins with sulfate rather than chloride. Because SBA resins bind sulfate selectively over NO_3 and AsO_4, but not over CrO_4 or ClO_4, only a small fraction of the influent NO_3 and AsO_4 entering an SBA column preloaded with sulfate would bind to the resin. Furthermore, the NO_3 and AsO_4 that did bind would not elute as potentially hazardous chromatographic peaks. Using sulfate as the regenerant anion will also reduce salt consumption during regeneration. Sulfate is expected to be an effective regenerant at a much lower concentration than chloride, since its affinity for SBA resins is typically about an order of magnitude greater than that of chloride. The savings associated with this reduction in salt consumption would more than offset the higher cost of the sulfate salt.

The modeling results documented in this paper will aid utilities that wish to use IX for CrO_4 or ClO_4 removal. Switching to sulfate brine has the potential to eliminate competing nitrate and arsenic chromatographic peaks, extend treatment cycles, and lower the utilities' O&M cost, without any significant changes in equipment. The work is expected to be especially valuable if the regulations for chromium and perchlorate are set and/or maintained at the low levels that are currently being discussed by the California Department of Health and the USEPA.

BIOS

PIERRE KWAN

Pierre Kwan, HDR Engineering – Bellevue, WA

Pierre Kwan is a project engineer with HDR Engineering. He is a member of AWWA and currently serves on the Pacific Northwest AWWA Water Treatment Committee. His work has included extensive bench- and pilot-scale testing for arsenic removal, iron and manganese control, and membrane filtration.

Pierre has a B.S. in Civil Engineering from the Ohio State University and a Masters in Civil Engineering from the University of Washington.

MARK M. BENJAMIN

Mark M. Benjamin, University of Washington – Seattle, WA

Professor Mark M. Benjamin has been on the University of Washington faculty in the Department of Civil Engineering since 1978. He is an expert in physical/chemical treatment processes in general, with long-term interests in the behavior of metals and natural organic matter (NOM) in water treatment systems. He has published extensively on the use of various treatment processes, including adsorption and membrane filtration, for removing NOM, metals, and oxyanions such as arsenic from drinking water. Dr. Benjamin's publications and his students' doctoral theses have been recognized by several awards. He recently completed a textbook on water chemistry and is working on another (with Desmond Lawler) on physical/chemical water treatment processes.

STEVE RIEBER

Steve Reiber, HDR Engineering – Bellevue, WA

Steve Reiber is the founder and manager of HDR's Water Quality Services Laboratory in Bellevue, Washington and is the Director of HDR's Water Research Program. He is a former associate professor at the University of North Carolina – Charlotte, and is currently on the faculty of the University of Washington Department of Civil Engineering. Dr. Reiber is a nationally known expert in water chemistry, most frequently recognized for his work on oxidation-reduction treatment processes and for the development of direct analytical techniques for corrosion assessment. He has invented several new methodologies, now widely applied, to assess corrosion in potable water systems. He has twice won the AWWA's most prestigious research award. He holds several patents, and his writing on a wide range of topics has been published in a variety of periodicals and books.

Steve has a Ph.D. in Civil Engineering from the University of Utah, two masters degrees – one in Civil Engineering from the University of Michigan and the other in Public Health from Johns Hopkins, and a B.S. in Biochemistry from the University of Michigan.

GENERAL SESSION I

ABSTRACTS & BIOS

THE HISTORY AND PLANS FOR THE CORRECTION OF A PERCHLORATE CONTAMINATION OF FOUR MUNICIPAL WATER SUPPLY WELLS DUE TO PAST PRACTICES ON 1000 ACRES OF A MUNITIONS FACTORY AND TESTING IN THE SANTA CLARITA VALLEY

(No abstract provided for this presentation)

BIO

ROBERT C. SAGEHORN
Robert C. Sagehorn is the General Manager of the Castaic Lake Water Agency. He is a native Californian, born in Sacramento. He has a B.S. in Irrigation Science from U.C. Davis. He has been employed on irrigation system improvement projects for the Solano Irrigation District and the South San Joaquin Irrigation District.

He served as General Manager of the Stockton-East Water District for 14 years and accomplished a water rights settlement on the Calaveras River, construction of irrigation check dams, construction of the first municipal water treatment plant serving the city of Stockton.

He has served as General Manager of the Castaic Lake Water Agency for 21 years. He increased State Water Project entitlement of the agency from 41,500 acre feet to 95,200 acre feet per year. He expanded treatment plant capacity from 12.5 MGD to 55 MGD, acquired 580-acre site for the Rio Vista Water Treatment Plant and worked with the city to construct a central park, acquired the Santa Clarita Water Company and legislation to operate the company at retail.

Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, CA 91350
(661) 297-1600 / (661) 297-1611 (Fax) / e-mail: mail@clwa.org

CASE STUDY OF PERCHLORATE: DEALING WITH AN EMERGING CONTAMINANT

(No abstract available)

BIO

BILL GEDNEY
Environmental Manager
Southern California Water Company
Corporate Office:
630 East Foothill Boulevard
San Dimas, California 91773
Telephone 909.394.3600
Fax 909.394.1382

NEW LEGAL ISSUES REGARDING PERCHLORATE: THE SANTA CLARITA LITIGATION

Andrew J. Yamamoto, Attorney at Law

Andrew J. Yamamoto, a partner at the Los Angeles office of Nossaman Guthner Knox & Elliott LLP, is a managing attorney in a lawsuit in which the clients are seeking environmental clean-up costs, damages and injunctive relief for the pollution of groundwater.
Four groundwater production wells have been impacted in the Santa Clarita area by perchlorate pollution with results showing perchlorate exceeding 40 parts per billion. All four wells are located close to and down gradient of a large munitions and rocket manufacturing site formerly owned and operated by the Whittaker Corporation. Two water agencies and two water companies are suing the Whittaker Corporation and two developers for the perchlorate pollution.
The presentation will include an introductory discussion of the litigation involving Santa Clarita, California and will focus on the new legal issues as well as the new regulatory and legislative changes that will affect perchlorate litigation in the future.

BIO

ANDREW J. YAMAMOTO
Partner, Nossaman Guthner Knox & Elliott,
445 S. Figueroa Street, 31st Floor, Los Angeles, CA 90071
Phone (213) 612-7896 Fax (213) 612-7801 / ayamamoto@nossaman.com

Professional Profile
Andrew J. Yamamoto is a partner at Nossaman Guthner Knox & Elliott, where he handles Environmental and Water Rights matters. Andy represents cities, developers, water companies, water agencies, and industrial concerns in a wide range of environmental matters and complex water rights litigation. He serves as counsel to both corporate and municipal clients in water cases, and has argued water rights issues before the State Water Resources Control Board. His environmental practice focuses on the Comprehensive Environmental Response, Compensation and Liability Act, the Hazardous Substance Account Act, the Resource Conservation and Recovery Act and common law environmental claims. He has taught courses on both environmental law and environmental litigation at the UCLA School of Law. He has also spoken on environmental topics at seminars and conferences for lawyers and business people. Currently, Andy is one of the lead attorneys representing a group of water agencies and water companies in the perchlorate suit against the Whittaker Corporation and others in Santa Clarita, California.
Representative Work

Environmental Law. Andy represents and advises clients in a wide range of environmental matters. His environmental practice includes representing or advising clients in matters involving the California Environmental Quality Act, CERCLA, the Clean Water Act, the Endangered Species Act, the HSAA, the National Environmental Policy Act, and RCRA.

Insurance Coverage. Andy represents and advises clients that have disputes with insurance companies concerning the coverage of environmental claims and cross-claims. His article entitled "Advise Your Clients to Save Old Insurance Policies" was published in the September 2001 issue of the Los Angeles Lawyer Magazine. He also advises companies and government agencies that have environmental claims on how to access the insurance policies of opposing parties.

Water Rights Law. Andy represents and advises clients in complex water rights litigation. He serves as counsel to both corporate and municipal clients in water cases, and has argued important water rights issues before the State Water Resources Control Board. Andy also assists clients on the water rights aspects of a variety of transactions, including advising clients on issues affecting development projects.

Professional Affiliations
Law Clerk to Judge David R. Thompson, US Court of Appeals for the Ninth Circuit, 1988-1989
Beverly Hills Bar Association, Governor, 2000-2001
California Minority Counsel Program, Steering Committee, 2001-Present.
Japanese American Bar Association, President, 1999-2000; Governor, 1993-2001
Los Angeles County Bar Association, Trustee, 1999-2001
UCLA School of Law, lecturer on CERCLA, CEQA, NEPA and ESA, 1993-1995

Education
J.D., University of California, Los Angeles, 1988, Order of the Coif
B.A., Yale University, 1983, *cum laude*

AN OVERVIEW OF PERCHLORATE REMEDIATION EFFORTS IN THE LAS VEGAS VALLEY

For approximately fifty years, ammonium perchlorate production has been ongoing in the Las Vegas Valley As a result of production, releases have occurred that have impacted soils and ground water. Through subsurface migration of contaminants, surface water impacts to the Las Vegas Wash, Lake Mead and the Colorado River have occurred. The discussion will include an overview of the innovative remedial efforts underway in the Las Vegas Valley and the unique cooperative relationships between the private sector and local, state and federal agencies.

BIO

ALLEN BIAGGI
Allen Biaggi has been with the Nevada Division of Environmental Protection for 23 years. He has a degrees in Surface Water Hydrology and in Architectural Engineering Design from the University of Nevada, Reno.

While at the Division, Mr. Biaggi has worked in the Water Pollution Control, Hazardous Waste, Air Pollution Control and Corrective Action programs. He headed the Solid Waste program and developed the Underground Storage Tank program, Petroleum Claims program and established the Bureau of Corrective Actions. He has been involved with remediation activities around the State and was the lead project officer for a number of clean up projects.

Mr. Biaggi was previously Deputy Administrator for the Division for the Water Pollution Control, Mining Regulation and Reclamation and Air Pollution Control programs. He was appointed Administrator of the Division in 1998.

CREATING PERCHLORATE STAKEHOLDER ALLIANCES IN THE SAN GABRIEL VALLEY, CALIFORNIA AND TEXAS

This presentation will describe how the affected communities in the San Gabriel Valley and in Central Texas created stakeholder alliances to respond to the threat of perchlorate. It will also describe how this outreach featured requests to the United States Congress to provide funding for the detection of perchlorate in the water supply and surrounding watersheds and construction of facilities for remediation.

A dual challenge of the affected communities in the San Gabriel Valley and the State of Texas was determining the degree of perchlorate contamination in the regional water supply and the surrounding watersheds and also working to prevent further contamination from the McGregor Naval Weapons Facility by launching a costly cleanup. An additional challenge was working with the Department of the Navy in support of these goals.

BIO

FRED B. HICKS
Fred B. Hicks was educated at the University of Chicago where he received his Ph.D. For the past 23 years, he has worked in Washington representing clients in the federal sector. These clients have included the East Valley Water District, the San Gabriel Valley Water Association, and the AWWA Research Foundation. Fred has been active in helping to secure perchlorate research funding from the Congress, and in helping local water agencies win federal funding to construct treatment facilities and assess the threat of perchlorate to regional drinking water supplies.

J. TOM RAY
Mr. Ray has been active in water resources planning and engineering for over 25 years. He is currently Water Resources Program Manager for the firm of Lockwood, Andrews and Newnam, Inc. and a partner in the firm of Hicks-Ray Associates.

Mr. Ray was with the Brazos River Authority in Waco, Texas for many years; he was most recently the Deputy General Manager. Prior to joining the Brazos River Authority in 1980, he was an engineer with Espey, Huston, and Associates, and a staff engineer with the Texas Water Quality Board.

Mr. Ray is a member of numerous water-related associations. He is a long-time board member of the Texas Water Conservation Association and chair of its recently

GENERAL SESSION II

ABSTRACTS & BIOS

PERCHLORATE CONTAMINATION CHALLENGE: STATUS OF EPA RISK CHARACTERIZATION

Annie Jarabek

Appreciation of widespread contamination by perchlorate in the United States emerged in the Spring of 1997 when development of an analytical method with a quantitation level at 4 ppb became available. By May of that same year EPA was engaged in developing a targeted testing strategy to evaluate the potential human health and ecotoxicological effects of potential perchlorate exposures. Efforts at risk characterization have necessarily involved an integrated approach that includes development of analytical methods and treatment technologies and the evaluation of potential risks to humans and ecosystems posed by the contamination. The purpose of this presentation is to provide an overview on the status of those efforts with an emphasis on health and ecosystem concerns. An outline of future steps toward regulatory action will also be provided.

BIO

ANNIE M. JARABEK

Annie Jarabek is a Special Assistant to the Associate Director for Health in the National Center for Environmental Assessment of the U.S. Environmental Protection Agency's Office of Research and Development. Trained as an inhalation toxicologist, Annie is the principal author of the EPA's methods to derive inhalation reference concentrations (RfCs) that incorporate dosimetry modeling of inhaled particles and gases to improve characterization of dose. Her current EPA research involves developing mode-of-action dosimetry models for the inhalation, oral, and dermal routes. Annie is also working currently as an EPA visiting scientist at the CIIT Centers for Health Research on a project developing value-of-information (VOI) analyses to formalize confidence in risk assessment descriptions based on dosimetry and mode-of-action information. She has contributed to the practice of using dosimetry modeling for route-to-route extrapolation and participated in technical reviews and negotiations to use pharmacokinetic data to inform alternative testing strategies. Annie represents the Agency on a number of public-private partnership steering committees that are developing case studies for the application of mode of action information per the 1996 proposed cancer assessment guidelines. Perchlorate is one of those projects. She currently serves as well on committees involved with evaluating how to harmonize approaches to risk assessment approaches of noncancer and cancer and on the use of biomarkers in risk assessment. She worked on implementation of the benchmark dose approach for dose-response modeling and has developed a Bayesian application that is similar but which also provides for statistical combination of dose-response estimates and allows for calculation of risk above reference levels. She is extending that work to combine health and ecotoxicological risk under an internal EPA grant. Annie has received one silver and three bronze medals for her work in the Agency. She has presented on dosimetry adjustments and statistical considerations for dose-response assessment to the Science Advisory Board of EPA, the National Academy of Sciences Board of Toxicology, the Toxicology Forum, and the EPA's Risk Assessment Forum. Annie is active in both Society of Toxicology (SOT) and the Society for Risk Analysis (SRA). Annie stepped down in 1998 from a three-year term as an elected councilor to the SRA and continues to serve on the annual meeting program and workshop committees. She has received three different awards for outstanding presentation from the Risk Assessment Specialty Section of SOT since 1992 and received an award for best manuscript in risk assessment application in 2001. Annie was elected as the Vice-President Elect of the Risk Assessment Specialty Section of the SOT in 2002.

WHAT DO HUMAN DATA TELL US ABOUT HOW MUCH PERCHLORATE EXPOSURE IS 'SAFE'?

Richard C. Pleus, Intertox, Inc., Seattle, WA,
Dept. of Pharmacology, University of Nebraska Medical Center, NE

In its most recent draft risk assessment of perchlorate (*Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization*), U.S. EPA proposed a revised reference dose (RfD) of 0.00003 mg/kg-day, which translates to a Drinking Water Equivalent Level (DWEL) of 1 ppb. Cal-OEHHA has proposed a Public Health Goal (PHG) of 6 ppb. U.S. EPA bases its proposed RfD on animal data derived primarily from rat studies, whereas Cal-OEHHA bases its value on a clinical study by Greer *et al.* (2002). The proposed RfD and PHG incorporate composite uncertainty factors of 300 and 60, respectively. Comparison of these values to human exposure data for perchlorate reveals that both are unnecessarily conservative.

Perchlorate has been used for over 50 years as a medication and is still approved by the FDA as a treatment for hyperthyroidism. This history provides a wealth of information about perchlorate's primary mechanism of action (*e.g.*, iodide uptake inhibition, IUI), high-level dose-response, and risk. However, to provide more information on perchlorate's no-effect level (NOEL) for IUI, the mechanism preceding adverse effects, human clinical trials were designed and implemented. At levels at or below the NOEL, no effects of *any* kind, including adverse effects, occur; thus determining the NOEL provides evidence of the exposure level that protects against any effects in the population. Greer *et al.* 2002 found a NOEL for IUI by perchlorate in humans of 0.007 mg/kg-day. This translates to a DWEL of 180 to 220 ppb – about 200 fold greater than the U.S. EPA's proposed RfD. Numerous other human studies support this as a level that produces no effects in humans, including sensitive subpopulations exposed for many years.

The NOEL implicitly protects sensitive subpopulations—experience with pharmaceutical agents shows us that a medication cannot exert a therapeutic *or* side effect at a dose that has no effect at all via the known mechanism of action. Because IUI is several steps removed from any adverse effect, application of additional safety factors to the NOEL for perchlorate (as proposed by U.S. EPA and Cal-OEHHA) is unnecessary. Hypothyroidism, for example, follows after significant changes in thyroid hormone levels, which do not occur unless significant IUI occurs for a sustained period. Greer *et al.* and others support this by showing that no changes in thyroid hormones or other blood chemistry parameters occur at perchlorate doses more than 70 times greater than the NOEL. Thus, use of the NOEL to set a DWEL implicitly incorporates safety factors.

U.S. EPA has implied and Cal-OEHHA has stated that IUI could be an adverse effect. However, IUI is a mundane and commonplace occurrence. Like most biochemical phenomena, many everyday factors cause changes in IUI, including stress, time of day and diet; thus, deeming any change in IUI as "adverse" implicates these other phenomena as well.

To assess the validity of the assumption that IUI is "adverse", we compared U.S. EPA's and Cal-OEHHA's estimates of "safe" perchlorate exposure to the level of IUI expected to occur daily from normal dietary intakes of other IUI-causing substances in common foods. Nitrate is an example—our analyses show that single servings of common nitrate-containing foods would cause tens to hundreds of times the IUI as the proposed RfD/DWEL or the proposed PHG. Green leafy vegetables widely viewed as healthy and nutritious are the greatest "offenders." This illustrates that both the U.S. EPA and Cal-OEHHA risk assessments are factually invalid: perchlorate cannot pose a public health risk (much less an imminent hazard) at exposures that cause IUI at levels hundreds or thousands of times lower than routine dietary exposures.

Simple principles of pharmacology combined with well-designed human clinical studies and comparative exposure assessment show that perchlorate exposures hundreds of times higher than the proposed RfD or proposed PHG are "safe."

BIO

RICHARD C. PLEUS
Richard C. Pleus, Ph.D.
Toxicologist and Principal
Intertox Inc.
2819 Elliot Avenue, Suite 201
Seattle, WA 98121
(206) 443-2115 / (206) 443-2117 (Fax)
E-mail: rcpleus@intertox.com

PERCHLORATE: THE TEXAS REGULATORY EXPERIENCE

Dr. Michael E. Honeycutt

The Texas Natural Resource Conservation Commission has been grappling with the perchlorate issue on several fronts for the past several years. Perchlorate has presented Texas with interesting challenges in the public drinking water, remediation, and wastewater permitting areas. Dr. Honeycutt will represent overviews of the perchlorate-contaminated federal facilities in Texas, highlighting ongoing remediation efforts. He will also discuss the recently-discovered perchlorate contamination of private wells and public drinking water supplies in two west Texas cities.

BIO

MICHAEL E. HONEYCUTT, PH.D.
Senior Toxicologist, Texas Natural Resource Conservation Commission

Dr. Honeycutt is a Senior Toxicologist and a Team Leader in the Toxicology & Risk Assessment Section of the Texas Natural Resource Conservation Commission (TNRCC). He has been employed by the TNRCC for over five years. He serves as the TNRCC representative on the Toxicology Subcommittee of the Interagency Perchlorate Steering Committee and as lead toxicologist for the TNRCC Perchlorate Working Group. Also, he serves as lead toxicologist for the TNRCC MTBE Working Group. His current responsibilities include reviewing and conducting human health risk assessments for hazardous waste sites and for hazardous waste combustion facilities. He also performs health effects reviews on air permit applications and on the results of ambient air monitoring projects. Dr. Honeycutt serves as a technical resource for TNRCC staff on issues concerning sediment and water quality, drinking water contamination, and soil contamination, as well as serving as an expert witness in public and legislative hearings and participating in public meetings.

PLEASE NOTE:
Due to a family emergency, a last minute substitution for Michael Honeycutt was necessary. His name is **STEVE WALDEN.**

CALIFORNIA'S EXPERIENCE WITH PERCHLORATE AND FUTURE DIRECTIONS

(No abstract)

BIO

STEVEN BOOK, PH.D.
Steve Book is a research scientist in the California Department of Health Services' Division of Drinking Water and Environmental Management in Sacramento. He provides consultation to the DHS Drinking Water Program on a variety of issues, including the evaluation of risks associated with drinking water contaminants.

Dr. Book also is currently serving as Chief of the Monitoring and Evaluation Unit, which collects monitoring data for regulatory compliance from drinking water systems throughout the state.

He has more than 30 years of experience in biology, toxicology, and risk and exposures assessment.

Dr. Book has been in state service for 15 years, serving in a variety of technical and management positions related to the application of science to public policy.

He also spent 13 years on the research faculty the UC Davis where he studied the toxicity of radioactive materials.

For three years, he was an environmental consultant, working primarily on human health and ecological assessments associated with cleanup of military Superfund sites, and Proposition 65 consultation.

Dr. Book has authored or co-authored more than 60 published papers and 50 technical reports—and has given more than 160 technical presentations—on radiation biology, public health, regulatory toxicology and risk assessment, and science and public policy.

Dr. Book's undergraduate degree is in biological sciences from UC Berkeley, and his MA in zoology and PhD in physiology are from UC Davis.

Dr. Steven Book
Drinking Water Program
California Dept. of Health Services
601 North 7th Street, MS 92
P.O. Box 942732
Sacramento, CA 94234-7320
(916) 322-1553 / (916) 323-1382 (Fax)
E-mail: sbook@dhs.ca.gov

GENERAL SESSION III

ABSTRACTS & BIOS

REMOVING PERCHLORATE FROM GROUNDWATER

MODERATOR: Traci L. Case

BIO

TRACI L. CASE
Project Manager, Research Management

Ms. Case joined the Foundation in January 1998. Prior to joining the Foundation, she served on active duty in the U.S. Army as a Medical Service Corps officer at Fort Carson, Colorado. She has an M.S. degree in environmental science and engineering from Colorado School of Mines and a B.S. degree in chemical engineering from the University of Texas at Austin.

RISK COMMUNICATION CASE STUDY

Dale R. Bowlus, Jr.
Environmental Scientist
U.S. Army Center for Health Promotion and Preventive Medicine
Deployment Environmental Surveillance Program
Aberdeen Proving Ground, Maryland

Communicating risk can be both challenging and stressful. It is an art and a science that requires skill and intuition for success. Too often scientists, engineers, safety and health specialists focus on the science and technical information and fail to account for critical components needed in communication. To avoid a disastrous experience, it is essential to have a communication plan in place and continuously evaluate the communication environment. As with any strategic planning process, there are basic rules, guidelines, tools, and techniques you should follow. The communication outcome will vary based on the audience(s) receiving the information, the circumstances surrounding the situation, the communication delivery channel, and the individual or media delivering the message.

This presentation will use technical and scientific examples surrounding perchlorate issues and indicate some key factors that effect people's perceptions and beliefs. Risk communication tools, techniques, and strategies will be suggested to build trust, effectively deliver sensitive and technical information, and calm or relieve fears and anxieties. The benefits of proactive communication, as well as reactive communication techniques will be discussed.

BIO

DALE R. BOWLUS, JR., M.S., REP, CHMM

Mr. Bowlus has over thirty years experience as an educator, trainer, and public speaker. As a senior environmental scientist with the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) at Aberdeen Proving Ground, Maryland, Mr. Bowlus provides technical oversight for the Deployment Environmental Surveillance Program. He served until recently as the USACHPPM advisor, program chief, senior instructor and training coordinator for risk communication for more than 13 years. He continues to serve as the Army Office of the Surgeon General's representative with several professional organizations and Department of Army and Defense working groups. Mr. Bowlus was the founder of the Army Risk Communication and Consultation Program and has facilitated and taught international hazardous material/waste management, health and ecological risk assessment, spill response techniques, as well as the key principles of risk and crisis communication.

Mr. Bowlus received a Bachelor of Science in Biology and an Education Degree from Bowling Green State University, Bowling Green, Ohio and a Master of Science Degree in Environmental Science from Morgan State University, Baltimore, Maryland. He has complete postgraduate work at Florida Institute of Technology, Drexel University, and University of Maryland. He maintains certifications as a Registered Environmental Professional and Hazardous Materials Manager at the Masters Level and has held teaching certifications in Ohio and Maryland.

His professional affiliations include the Society for Risk Analysis, numerous committees and offices with the American Society for Testing and Materials, and the National Environmental Health Association.

WHAT'S BUBBLING TO THE TOP?

Rebecca T. Parkin, Ph.D., MPH
Center for Risk Science and Public Health of The George Washington University
Washington, DC

New strategies for recognizing and addressing emerging contaminants in drinking water have not been fully developed. Public concerns about potential contaminants will continue to occur, but the origins of public views are not well understood. Most agencies and organizations judge the potential for contaminants to cause harm based on scientific criteria such as potency, and severity of related adverse health effects. However, public risk perceptions around a "new" contaminant may be more influential than science in determining risk communication priorities and needs. Recognizing the gap between current practice and communication needs, we have begun to develop new methods and tools to identify potential emerging contaminants, and risk communication strategies to address them. New frameworks and ways to approach risk communications about emerging contaminants will be presented.

BIO

Rebecca T. Parkin, Ph.D., MPH
Environmental and Occupational Health
School of Public Health and Health Services
The George Washington University Medical Center
2300 K Street, NW, Suite 201, Washington, DC 20037
202-994-5482 - eohrtp@gwumc.edu

Dr. Parkin is an Associate Research Professor in the Department of Environmental and Occupational Health, with a joint appointment in the Department of Epidemiology and Biostatistics, of the School of Public Health and Health Services. She received her BA in Sociology from Cornell University, her MPH in Environmental Health and Ph.D. in Epidemiology from Yale University, and her Certificate in Science, Technology and Policy from Princeton University.

She serves on boards and committees of the National Research Council (NRC), Institute of Medicine (IOM), U.S. Environmental Protection Agency (EPA), and the Centers for Disease Control and Prevention (CDC). Dr. Parkin also serves on local advisory boards and is an invited speaker to international conferences. She has served as the Assistant Commissioner of Occupational and Environmental Health in the New Jersey Department of Health and as an environmental epidemiologist at CDC.

Dr. Parkin is the Director of Science in the Center for Risk Science and Public Health of The George Washington University Medical Center. She is currently the Principal Investigator of research projects sponsored by the U.S. EPA, Association of Occupational and Environmental Clinics (AOEC) and the American Water Works Association Research Foundation (AWWARF). She is also an investigator on the AOEC-sponsored Mid-Atlantic Pediatric Environmental Health Specialty Unit. Her research and teaching is focused on risk assessment, susceptible subpopulations, vaccination and environmental health risk perception, and risk communication. She is co-author of a book on waterborne microbial pathogens soon to be published by the American Water Works Association.

PERCHLORATE: PROBLEMS, DETECTION AND SOLUTIONS

Dr. William E. Motzer, Senior Geochemist with Todd Engineers

The perchlorate anion is produced when the solid salts of ammonium, potassium and sodium perchlorate and perchloric acid dissolve in water. Ammonium perchlorate, used in solid rocket engine fuels, has a limited shelf life and must periodically be replaced. Before 1997, perchlorate could not be readily detected in groundwater at concentrations below 100 mg/L, until the California Department of Health Services developed an acceptable analytical method that lowered the detection limit to 4 mg/L. Subsequently, groundwater containing perchlorate were soon encountered in several western states, and contamination became apparent in Colorado River water. Most perchlorate salts have high water solubilities; concentrated solutions have densities greater than water. Once dissolved, perchlorate is extremely mobile, requiring decades to degrade. Health effects from ingesting low dosage perchlorate-contaminated water are not well known. It interferes with the body's iodine intake, causing an inhibition of human thyroid production. Contaminated surface and groundwater treatment may require bio- and/or phytoremediation technologies, Perchlorate in groundwater is relatively unretarded; it probably travels by advection. Therefore, it may be used as a tracer for hydrocarbon and metal contaminants that are significantly more retarded. Possible forensic techniques include chlorine isotopes for defining multiple or commingled perchlorate plumes.

BIO

DR. WILLIAM E. MOTZER

Dr. William E. Motzer, Senior Geochemist with Todd Engineers in Emeryville, California has more than 24 years of experience as a Professional Geologist and more than 16 years of experience in conducting surface, subsurface, and environmental geochemical investigations. He is a California registered geologist, is also a registered geologist in six other states, and holds a doctorate from the University of Idaho in geology. He has conducted and managed more than 300 environmental audits, site assessments, remedial and forensic geochemical investigations, and expert witness testimony throughout California and in other states across the U.S. for realtors, lending institutions, attorneys, private corporations, insurance companies, state agencies, and municipalities. Dr. Motzer recently completed a geochemical study for a drinking water source assessment for the Soquel Creek Water District in Soquel, California – an investigation that determined that low part per billion concentrations of hexavalent chromium in groundwater were from natural sources. He has provided litigation support for several water companies and PRPs in Los Angeles County with respect to perchlorate contamination in water supply wells. He has also conducted inorganic analysis of groundwater in a perchlorate-impacted area in northern California.

In addition to his project work, Dr. Motzer has been an instructor at the University of California – Berkeley Extension program for environmental management. Since 1992, he has taught *Applied Environmental Geochemistry* and *Geology and Geochemistry in Hazardous Waste Disposal* courses and a *Forensic Geochemistry* workshop. He also conducted the *Forensic Geochemistry* workshop for the University of Wisconsin Extension in Denver, Colorado and a *Natural Water Quality* workshop for the University of California – Berkeley Extension under a contract with the East Bay Municipal Utilities District (EBMUD). He convened and co-chaired the *Environmental Forensics/Forensic Geochemistry Symposium* at the 2000 Joint Annual Meeting of the Association of Engineering Geologists and Groundwater Resources Association of California (GRAC) in San Jose, California. In March 2001, he gave a presentation on *Forensic Geochemistry* to the Ground Water Environmental Group – Lawrence Livermore National Laboratory, Livermore, California. He recently gave a presentation to the Soquel Creek Water District in Soquel, California on the geology and geochemistry of hexavalent chromium in California groundwater and possible forensic geochemical methods for distinguishing between natural and anthropogenic hexavalent chromium. In November 2002, he will be chairing an *Environmental Forensics* workshop for the San Francisco Section of the GRAC. Dr. Motzer has also been a reviewer for the journal *Environmental Geochemistry and Health* and is currently on the editorial board of the journal *Environmental Forensics*. He recently published a paper on perchlorate and is an author for an upcoming text on the geochemistry of hexavalent chromium.

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA'S ACTION PLAN FOR ADDRESSING PERCHLORATE IN COLORADO RIVER WATER SUPPLIES

Marcia Torobin

Metropolitan Water District of Southern California (Metropolitan) has been addressing the issue of Perchlorate contamination since it was first detected in 1997. However, the release of the U.S. Environmental Protection Agency's draft Perchlorate risk assessment and California's Office of Environmental Health Hazard Assessment' (OEHHA) draft public health goal report have heightened concerns and highlighted the need for further action. Recently Metropolitan implemented a Perchlorate Action Plan (Plan) that builds upon existing efforts to address Perchlorate contamination in Colorado River Water Supplies. The Plan's components include: monitoring; resource assessment; tracking health effects studies; tracking remediation efforts; modeling; legislative and regulatory strategies; and outreach activities.

BIO

MARCIA TOROBIN
Marcia Torobin is a member of Metropolitan Water District of Southern California's legislative and regulatory staff where she is responsible for developing policy recommendations on various drinking water quality legislative and regulatory issues. Ms. Torobin also manages Metropolitan's water quality consumer research activities and serves on American Water Works Association's (AWWA) Economics Technical Advisory Workgroup. She has spoken at regional and national conferences on source water protection, consumer communications, and consumer perceptions of taste and odor in drinking water.

Ms. Torobin holds Master of Science degrees in both Finance and Environmental Health Sciences and advanced to candidacy in the Environmental Science and Engineering doctoral program at the University of California, Los Angeles.

PAPERS and PUBLICATIONS:
Torobin, M.G., Johnson, T.D., and Suffet, I.H. The Importance of Water Quality Aesthetics in Consumer Confidence in the Safety of Drinking Water Supplies, 1999 AWWA Annual Conference and Exposition, Chicago.

Hayes-Bautista, D.E., Torobin, M.G., Hayes-Bautista, M., Beuhler, M.D., and Parekh, P. Communication with a Multicultural Customer Base in a Southern California Utility: An Exploratory Step, Unpublished Paper, 1999.

Torobin, M.G. Tools for Source Water Protection: Regulation and Incentives, Source Water Protection Symposium: A Focus on Waterborne Pathogens, AWWA, San Francisco, 1998.

Pedersen, D.W., Luitweiler, J.P., and Torobin, M. Working with the USDA to Protect Source Water, AWWA Journal, 90:3, 51, 1998.

PERCHLORATE REMEDIATION AT THE LAS VEGAS WASH

The main source of perchlorate entering the Colorado River is from a manufacturing facility near the city of Las Vegas, Nevada. Ammonium perchlorate, a principal component of solid rocket fuel, has permeated into the groundwater under the manufacturing site, which flows into the Las Vegas Wash and then into Lake Mead. Perchlorate detected in Colorado River supplies has been traced to this source.

To reduce the perchlorate levels flowing into the Las Vegas Wash, Kerr-McGee has constructed an 825-gallon per minute (GPM) treatment facility designed to intercept and treat a major groundwater plume prior to discharge into Lake Mead. The ion-exchange facility built by Kerr-McGee utilizes a state-of-the-art ion-exchange process that captures and treats perchlorate concentrated water by attracting perchlorate ions onto a bed of synthetic resin. These units, manufactured by Calgon Carbon, are designed to remove greater than 95 percent of the perchlorate from the groundwater prior to discharge back into the Las Vegas Wash.

The Nevada Division of Environmental Protection (NDEP) is overseeing the Kerr-McGee clean-up operation. NDEP describes the installation of the 825-GPM treatment facility as part of a multi-phased approach toward cleaning up the discharge of perchlorate into Lake Mead. Subsequent phases may include identifying, intercepting, and treating additional groundwater seepage into the wash. Once perchlorate stops entering the Las Vegas Wash, the remaining concentration of the chemical will decrease based on the low in the Colorado River and other hydrological dynamics throughout the Lake Mead/Lake Mojave/Lake Havasu water system.

Unrelated to the Colorado River, perchlorate was first detected in drinking water wells in northern California adjacent to a rocket testing and manufacturing site in February of 1997. The State of California's Department of Health Service (CDHS) initiated sampling for drinking water utilities throughout the state to assess the vulnerability of systems to this chemical. Perchlorate was subsequently detected in groundwater water wells adjacent to rocket fuel test and fireworks manufacturing facilities in the Los Angeles, Riverside and San Bernardino counties. At the same time Metropolitan initiated testing of its source water supplies. This testing led to the identification of the Las Vegas Wash discharge of perchlorate.

On January 18, 2002, the U.S. Environmental Protection Agency (EPA) released a draft toxicological report on perchlorate in drinking water. The reports recommendations translate to a drinking water equivalent level (DWEL) of 1 part per (ppb). CDHS followed this report by lowering its previous consumer-based advisory health action level from 18 ppb to 4 ppb. The State of California Office of Environmental Health Hazard Assessment has proposed a Public Health Goal of 6 ppb, which is the first step in California's standard setting process. Both EPA and CDHS are working toward setting an enforceable perchlorate drinking water standard.

BIO

EDGAR DYMALLY
Representing the California-Nevada Section of AWWA
(213) 217-5709 / E-mail: edymally@mwdh2o.com

GENERAL SESSION IV

ABSTRACTS & BIOS

OVERVIEW OF DOD PERCHLORATE EFFORTS: A DISCUSSION OF DOD EFFORTS IN REGARDS TO TOXICOLOGY AND REMEDIATION

Bryan Harre, Presenter

Perchlorate, the stable anion of ammonium perchlorate, is found in groundwater and drinking water throughout the United States. The contamination is the result of the use of ammonium perchlorate in solid rocket fuel of rockets and missiles. The current status of perchlorate will be presented.

PERCHLORATE REMEDIATION TECHNOLOGY PILOT TESTS AT NASA'S JET PROPULSION LABORATORY

Richard J. Zuromski, Jr., P.E. (Naval Facilities Engineering Service Center), Peter Robles, Jr. (National Aeronautics and Space Administration), and Keith A. Fields

Groundwater containing perchlorate is an increasingly pervasive problem in California, having been found in 30% of the wells sampled, and has chronic adverse human health effects at low levels. The California Department of Health Services (CDHS) has established a provisional action level of 4 mõg/L for perchlorate due to interference with iodine in the production of hormones in the human thyroid. Remediation of low levels (less than 1 mg/L) of perchlorate in groundwater is a problem faced by many private and federal facilities.

Several technologies (such as reverse osmosis, anion exchange, and biological reactors) exist to treat high levels of perchlorate; however, there is limited research demonstrating that these same technologies are effective for treating low levels of perchlorate in groundwater. Taking this into account, the Naval Facilities Engineering Command (NAVFAC) and the National Aeronautics and Space Administration (NASA) have conducted pilot-scale testing of several ex-situ technologies for treating perchlorate-impacted groundwater at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, CA. Concentrations of perchlorate in groundwater at the JPL range from ND to 1,900 mõg/L.

These technologies include two ion exchange systems, a fluidized bed bioreactor, and three packed bed bioreactors. NAVFAC and NASA tested these technologies on one groundwater well at JPL to ensure consistency of operational parameters. NAVFAC and NASA also performed microcosm studies on this same groundwater well to assess the potential for in-situ biodegradation of low levels of perchlorate. This paper summarizes the results of the pilot-scale testing of the ex situ treatment technologies, microcosm study results from the in situ biodegradation study, as well as lessons learned including potential chemical interferences during operation and treatment, avoidable costs, limitations, and regulatory issues. It also discusses current considerations for a full-scale remedial action.

BIO

MR. RICHARD J. ZUROMSKI, JR., P.E.
Mr. Richard J. Zuromski, Jr., P.E. has worked for the Navy for over six years. He has experience in environmental compliance and management, pollution prevention, and installation restoration. He spent three years working on the NFESC Broad Agency Announcement program demonstrating innovative environmental restoration technologies, and served as the Technical Evaluation Board Chairman. Mr. Zuromski currently serves as a Contracting Officer's Technical Representative on Navy and Marine Corps environmental restoration contracts involving innovative cleanup technologies. Since September 1999, he has been the Navy project manager for the JPL Superfund remediation project in Pasadena, Ca. Mr. Zuromski has prior experience working as an environmental engineer for the Ventura County Air Pollution Control District and Vandenberg Air Force Base, and as an engineering assistant for the State of California Regional Water Quality Control Board, Central Coast Region and Texaco Refining and Marketing, Inc. Mr. Zuromski received his B.S. degree in Environmental Engineering from the California Polytechnic State University in San Luis Obispo. He is currently a third-year law student working toward a Juris Doctor degree at Loyola Law School in Los Angeles. Mr. Zuromski is a registered professional engineer (proficiency in environmental engineering) in the State of Arizona. Mr. Zuromski can be reached at: Naval Facilities Engineering Service Center, 1100 23rd Avenue, Code 414, Port Hueneme, CA 93043. Tel: (805) 982-1488 / Fax: (805) 982-4304

Author Two: Peter Robles, Jr.
National Aeronautics and Space Administration, Jet Propulsion Laboratory, 4800 Oak Grove Dr., M/S 180-801, Pasadena, CA 91109 Tel: (818) 393-2920 / Fax: (818) 393-2160

TOXICITY AND RISK ASSESSMENT: A DOD PERSPECTIVE

Perchlorate, the stable anion of ammonium perchlorate, is found in groundwater and drinking water throughout the United States. The contamination is the result of the use of ammonium perchlorate in solid rocket fuel of rockets and missiles. Perchlorate competes with iodine for uptake into the thyroid gland resulting in iodine deficiency and hypothyroidism at large mg doses. Sodium or potassium perchlorate has been used for over 50 years as a drug in the clinical setting (doses up to 900 mg/day) to treat hyperthyroidism due to Graves Disease or to reverse the side effects of administration of amiodarone. The initial provisional reference dose (RfD) for perchlorate was 4 ppb in 1992 based on inadequate toxicity data and uncertainty factors equal to 1000. A battery of toxicity studies has been conducted to collect data necessary for the determination of an oral reference dose for perchlorate. The design of the studies was based on the mode of action of perchlorate. Data now exists for human exposure in the workplace, in exposed populations and from volunteers in clinical studies. The rat is more sensitive to perchlorate than the human. Use of rat data and application of precursor effects (iodine inhibition and hormone changes) seen in rats at low levels of perchlorate resulted in the low proposed RfD. Use of human data supports an RfD in the range of 60 to 100 times higher than the value proposed (1 ppb) in the EPA draft document released in January 02. The current status of perchlorate will be presented.

BIO

DAVE R. MATTIE
Dr. Mattie is currently a Senior Research Toxicologist in charge of Research Operations in the Operational Toxicology Branch of the Human Effectiveness Directorate, Air Force Research Laboratory, Wright-Patterson AFB, OH. Dr. Mattie received his bachelor's degree in Biology from Quincy College in Quincy, IL in 1974; his master's in 1977 and Ph.D. in 1983 from the University of Dayton, Dayton, OH.

Dr. Mattie joined the toxicology group at Wright-Patterson in 1978 as an electron microscopist. He was certified as a Diplomat of the American Board of Toxicology in 1991. His research activities include jet fuel toxicity, toxicity of propellants and Air Force program manager for the toxicity projects leading to the development of an oral RfD for ammonium perchlorate.

Professional affiliations include membership in the Society of Toxicology; Sigma Xi; and Ohio Valley Society of Toxicology (OVSOT). He is a Councilor for the OVSOT. Dr Mattie is also an Adjunct Associate Professor in both the Department of Veterinary Biosciences at the University of Illinois and the Department of Biology at the University of Dayton.

BIOS

G. CORNELL LONG, M.S.
Mr. Long is chief of the Health Risk Assessment Branch in the Air Force's Institute for Environment, Safety and Occupational Health Risk Analysis, Brooks Air Force Base, TX, which he joined in April 1993. He received his Bachelor of Science degree in Chemistry from New Mexico Highlands University (1984) and Master of Science degree in Environmental Science from the University of Texas at San Antonio (1996). Mr. Long's government career began in 1986 at the Air Force's Drug Testing Laboratory where he worked as a supervisory chemist in drug extractions from 1986-88. From there he moved to the Air Force Occupational and Environmental Health Laboratory where he performed and directed analysis of environmental and occupational samples for the presence of pesticides, polychlorinated biphenyls (PCB) and metals. He was a member of the American Chemical Society from 1989-96 and has been a member of the Society of Risk Analysis since 1998.

Since joining the Health Risk Assessment Branch, Mr. Long has been involved in describing human and ecological exposures to hazardous wastes at Air Force sites nationwide. He teaches regularly at the Air Force Institute of Technology (AFIT) and also at the United States Air Force School of Aerospace Medicine (USAFSAM) on the topics of environmental risk assessment and public health assessment methodology. In January 1998, Mr. Long was named as the co-chair of the ecological subcommittee of the Interagency Perchlorate Steering Committee (IPSC). The purpose of this subcommittee is to examine potential effects of perchlorate, an oxidizer in solid rocket boosters, on ecological receptors, to include plant uptake and human and animal consumption of agricultural products that may be affected by perchlorate.

DR. JODY WIREMAN

Dr. Jody Wireman has over 10 years of environmental and public health experience, including over nine years of experience supporting Air Force cleanup and compliance programs. He received a Master's degree in environmental health from the University of Alabama at Birmingham and a Doctorate in environmental toxicology from Texas Tech University. Dr. Wireman accomplishes site-specific risk assessments, risk assessment reviews, sample plan development and completion, food-chain/ ecological evaluations, toxicology support, assistance with ATSDR-related activities, and Restoration Advisory Board support and training. Currently, he is a technical advisor on Air Force human and ecological health projects, project manager for toxicological review of aircraft wash products, and a member of the Tri-Service Ecological Risk Assessment Workgroup and American Industrial Hygiene Association's Workplace Environmental Exposure Levels Committee.

Dr. Jody Wireman, Ph.D., MSPH, AFIERA/RSRE
2513 Kennedy Circle, Brooks AFB TX 78235-5114
E-mail: jody.wireman@brooks.af.mil / Phone: (210) 536-6123 / Fax: 210-536-1130

CHRISTOPHER J. SALICE

Christopher J. Salice is an environmental toxicologist at the U.S. Army Center for Health Promotion and Preventative Medicine, Health Effects Research Program at Aberdeen Proving Ground, Maryland. He received his B.S. in Environmental Science from Drexel University, Philadelphia and his Ph.D. in Toxicology from the University of Maryland, Baltimore.

His primary research interest is in evaluating the impact of environmental pollutants on ecological systems with an emphasis on population-level effects. Current projects are aimed at determining the toxicity of military unique compounds to terrestrial wildlife species and developing toxicity reference values for a number of compounds. Future efforts will include studies on evolutionary responses to environmentally relevant toxicants.

Dr. Salice is a member of the Army Biological Technical Assistance Group (BTAG) and the Tri-Service Ecological Risk Assessment Working Group (TSERAWG).

Christopher J. Salice, Ph.D.
Health Effects Research Program,
U.S. Army Center for Health Promotion and Preventive Medicine
5158 Blackhawk Rd. ATTN: MCHB-TS-THE
Aberdeen Proving Ground, MD 21010-5403
T: 410-436-8769 / F: 410-436-8258
Christopher.Salice@APG.amedd.army.mil

PERCHLORATE TOXICITY SCREENING LEVEL DEVELOPMENT FOR AQUATIC AND TERRESTRIAL SPECIES

Wireman JR, Johnson MS, Salice CS, Palachek RM, and Long GC

Although a number of aquatic and terrestrial toxicity studies have been and are being conducted for perchlorate, attempts to develop Ambient Water Quality Criteria (AWQC) and Terrestrial Reference Values (TRVs) have not been initiated. Using input from EPA and State regulators, we conducted a number of aquatic bioassays and bioconcentration studies to provide sufficient information necessary to develop EPA-approved AWQC for perchlorate.

In addition, since amphibians appear to be most sensitive to water-borne perchlorate exposures, we evaluated the morphological and developmental effects of perchlorate on a native amphibian species. For terrestrial species, the need to reduce repetition, variability and costs associated with the development of screening benchmarks for wildlife initiated the development of a clear method to derive TRVs.

Since publication two years ago, this method (TG 254) has been used to derive TRVs for several munitions and other military-relevant substances. The final chemical-specific product is peer reviewed Wildlife Toxicity Assessment (WTA), which provides a review of the toxicity data, along with the methods and rationale used to derive each TRV. This presentation will provide an update on the current status of efforts by the Department of Defense (DOD) and its partners to define reasonable, scientifically based approaches to evaluating ecological impacts of perchlorate with emphasis on the development of AWQC and TRVs to encourage consistent site-specific evaluations.

FINAL SESSION

ABSTRACTS & BIOS

RESPONSIBLE GUARDIANS: A DISCUSSION OF PERCHLORATE - AND THE NEXT GENERATION OF ALPHABET SOUP

Gerard J. Thibeault, Dr. Michael Honeycutt, Timothy F. Moore, Anthony (Butch) Araiza
(No abstract)

BIOS

TIMOTHY F. MOORE

Timothy Moore founded Risk Sciences in 1986. His firm specializes in developing site-specific water quality criteria and NPDES permit limits for municipal and industrial dischargers throughout the U.S. He has successfully negotiated state and federal requirements for ammonia, chlorine, heavy metals, pesticides, dissolved solids, nitrate, pathogens, whole effluent toxicity and TMDLs. He has a M.A. from Auburn University, Auburn, AL, a B.S. from University of Utah, Salt Lake City, UT, and post-graduate work at University of Arizona, Tucson, AZ.

Risk Sciences, 1417 Plymouth Dr., Brentwood, TN 37027
(615) 370-1655 / (615) 370-5188 (Fax) / E-mail: tmoore@risk-sciences.com

GERARD J. THIBEAULT

Executive Officer w
Santa Ana Regional Board
3737 Main Street, Suite 500, Riverside, CA 92501
(909) 782-3284 / (909) 686-8016 (Fax) / E-mail: gthibeau@rb8.swrcb.ca.gov

MICHAEL E. HONEYCUTT, PH.D.

Senior Toxicologist, Texas Natural Resource Conservation Commission

Dr. Honeycutt is a Senior Toxicologist and a Team Leader in the Toxicology & Risk Assessment Section of the Texas Natural Resource Conservation Commission (TNRCC).

PLEASE NOTE:
Due to a family emergency, a last minute substitution for Michael Honeycutt was necessary. His name is **STEVE WALDEN.**

SENATOR NELL SOTO

BIO

SENATOR NELL SOTO
Senator Nell Soto has devoted most of her adult life to community and public service. As a sixth generation resident of Pomona, persistence and tenacity have been the hallmarks of her career. Her hard work paid off when she was elected to the State Assembly in 1998 to represent the 61st District. With her election to the Senate, Senator Soto now represents a total of 10 cities: Chino, Montclair, Pomona, Ontario, Fontana, Colton, Rialto, San Bernardino, and the unincorporated areas of Bloomington and Muscoy.

In the Assembly, Soto's focus was on issues that most directly improved the lives of her constituents. Her legislative priorities in the Senate are now to continue along the common sense path and to create a safe, healthy and happy environment for her constituents. During her tenure in the State Legislature, Senator Soto has secured nearly $5 million in state funding for various projects in the Inland Empire.

Her election to the Senate made her the first woman elected to represent the Inland Empire in the Legislature.